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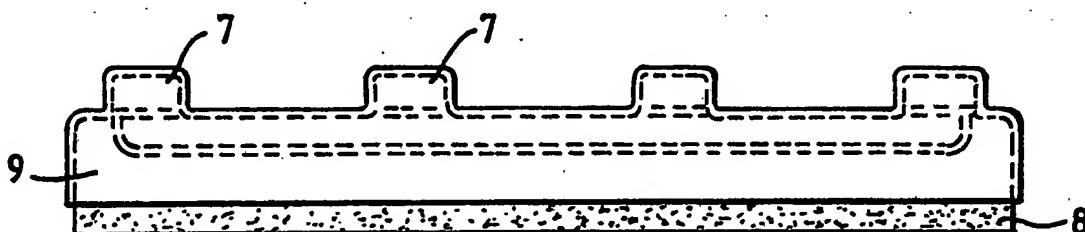
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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁵ :	A1	(11) International Publication Number:	WO 92/08257
H01R 4/70		(43) International Publication Date:	14 May 1992 (14.05.92)
(21) International Application Number:	PCT/GB91/01904	(74) Agent:	BENSON, Everett, John; Intellectual Property Law Department, Raychem Limited, Faraday Road, Dorcan, Swindon, Wiltshire SN3 5HH (GB).
(22) International Filing Date:	30 October 1991 (30.10.91)	(81) Designated States:	AT (European patent), BE (European patent), CH (European patent), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB (European patent), GR (European patent), IT (European patent), LU (European patent), MG, NL (European patent), SE (European patent), US.
(30) Priority data:	9024101.9 6 November 1990 (06.11.90) GB	Published	<i>With international search report.</i>
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(54) Title: A METHOD OF ENVIRONMENTALLY SEALING AN ELECTRICAL APPARATUS AND AN ARTICLE FOR SUCH A SEALING



(57) Abstract

A method of environmentally sealing an electrical apparatus having a surface provided with a plurality of wire interconnection means, by means of an article comprising: (a) a sealing material; and (b) cover means for containing the sealing material; which method comprises: (1) applying the article to the surface such that the sealing material is compressed against the surface; and (2) fixing the cover means against substantial movement with respect to the surface by either (i) connecting it to one or more of the wire interconnection means in such a manner that the sealing material is maintained under compression between the cover means and the substrate, or (ii) applying a compression means against the cover means, the compression means cooperating with upstanding projections on the cover means, so as to maintain the sealing material under compression between the cover means and the substrate.

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A METHOD OF ENVIRONMENTALLY SEALING AN ELECTRICAL APPARATUS
AND AN ARTICLE FOR SUCH A SEALING

This invention relates to the environmental protection of electrical apparatus and more particularly to an article and method for sealing or isolating sensitive electrical apparatus to avoid the adverse effects of contact with the environment.

Whilst the invention is applicable to the environmental protection of electrical apparatus in general, it will be described principally in relation to the protection of telecommunications cross-connector modules where particularly severe problems are frequently encountered.

Telecommunications cross-connector modules are usually mounted in outside plant such as road-side cabinets or pedestals, and are used, for example to connect large pair-count cables from the exchange to the smaller cables of the local network of subscribers.

Normally the large pair-count cable is permanently attached to the rear of the connector module, but access must be provided at the front for the installer to re-route and re-distribute the smaller cables of the local network.

If a cross-connector module is to function properly over its desired lifetime, which may be twenty years or more, environmental influences, for example dust, insects, and particularly moisture, must be kept at bay. The road-side cabinets and pedestals are frequently sited in exposed positions and are subject to extreme changes of temperature giving rise to condensation problems and corrosion.

A typical cross-connector cabinet or pedestal may contain a rectangular array of around 140 connector modules. Each connector module has provision on its front face for the interconnection of a number of pairs of telephone wires, normally consisting of a number of screw-threaded holes into which screws or connectors with screw threaded shanks can be fitted. The front face of the connector block is usually exposed to the environmental inside the cabinet or pedestal and corrosion is a frequent problem.

European Patent 0108518 describes and claims an apparatus for protecting a substrate comprising
a support member,
an encapsulant which is adherent to the support member and has a cone penetration value of 100 to 350 (10^{-1} mm) and an ultimate elongation of at least 200%, and
means for deforming the encapsulant into close and conforming contact with the substrate.

US Patent 4718678 describes and claims a method of environmentally sealing an indented surface by means of an article comprising:

- (a) a support;
 - (b) a sealing material; and
 - (c) a substantially elastically deformable means for maintaining the sealing material under compression; which method comprises:
 - (1) applying the article to the surface such that the sealing material is displaced partially into the indentations and the means (c) is deformed; and
 - (2) fixing the support against substantial movement with respect to the surface;
- the means (c) being capable of maintaining the sealing material under compression after step (2) and after some

subsequent displacement of the sealing material further into the indentations.

Both of these proposals work well in practice, but certain telephone companies use several different types of connector module, and there is a need for a versatile article and method of sealing which can be used in a number of different configurations.

The present invention provides a method of environmentally sealing an electrical apparatus having a surface provided with a plurality of wire interconnection means, by means of an article comprising:

- (a) a sealing material; and
- (b) cover means for containing the sealing material;

which method comprises:

- (1) applying the article to the surface such that the sealing material is compressed against the surface; and
- (2) fixing the cover means against substantial movement with respect to the surface by either (i) connecting it to one or more of the wire interconnection means in such a manner that the sealing material is maintained under compression between the cover means and the substrate, or (ii) applying a compression means against the cover means, the compression means cooperating with upstanding projections on the cover means, so as to maintain the sealing material under compression between the cover means and the substrate.

Preferably the plurality of wire interconnection means comprises a plurality of screw-threaded holes and the cover means is provided with one or a plurality of holes which align with corresponding screw-threaded holes in the surface.

Another aspect of the invention provides a method of environmentally sealing an electrical apparatus having a surface provided with a plurality of screw-threaded holes, by means of an article comprising:

- (a) a sealing material; and
- (b) cover means for containing the sealing material;

which method comprises:

- (1) applying the article to the surface such that the sealing material is compressed against the surface; and
- (2) fixing the cover means against substantial movement with respect to the surface by connecting it to one or more of the screw-threaded holes in such a manner that the sealing material is maintained under compression between the cover means and the substrate.

The cover may have one or more fixing holes or other means of attachment to the surface, but usually four such fixing points are sufficient. In another embodiment the cover means may be held fixed by a bar plate or flange.

In the simplest arrangement where the wire interconnection means comprises a screw-threaded hole in the surface of the electrical apparatus and a cooperating screw, removal of the screw, aligning of the holes in the cover and the surface and replacement of the screw, enables the cover to be fixed relative to the surface. Further tightening of the screw compresses the sealing material between the cover means and the surface to provide the required environmental seal.

In another embodiment, the cover is provided with one or more, preferably at least two, most preferably 4, upstanding projections which can cooperate with a compression bar, plate, or flange, laid across the cover so as to maintain the sealing material under compression against the substrate. Preferably the projections are at the edges of the cover means and form a central channel within which the compression means can rest, the projections preventing slippage of the cover and fixing it against substantial movement with respect to the surface. The projections can be conveniently moulded into the cover when the cover is formed.

The compression means may extend wholly or partly across the width or length of a cabinet, and in this way many connector module covers may be secured at the same time, obviating the need for removing the screws from each connector.

Preferably the cover is provided both with fixing holes and upstanding projections so that the greatest versatility in use can be obtained.

It is sometimes preferable for the cover to be transparent so that the sealing material can be inspected. The cover means is desirably moulded or otherwise formed from a rigid thermoplastic material, and is preferably in the form of a shallow tray, or container. The thickness of the cover means is preferably from 1.0 to 2.0 mms, especially from 1.5 to 1.6 mm. To add increased rigidity the cover may be provided with one or more moulded-in reinforcing ribs.

It is generally desirable that the cover and the sealing material can be readily removed so that repeated access to the connector module can be obtained. It is highly preferable that re-entry be clean ie that on removal of the article from the surface the sealing material comes away cleanly from the surface and remains intact, preferably adhered to the cover means. For this reason the cohesive strength of the sealing material is preferably high.

By a cohesive strength, therefore, we mean a cohesive strength greater than the adhesive strength of the material to the surface (which will be determinable in practice by the skilled man who will be conversant with the limited materials that will serve as surfaces in this art). The absolute value of the cohesive strength will depend on the nature of the re-entry operation and the frequency with which it is to be performed. The cohesive and adhesive strength will vary according to the rate at which one attempts to remove the sealing material from the surface. The

above consideration is to be taken at slow removal, at which cohesion is more likely to be greater than adhesion. If the sealing material is attempted to be removed quickly a layer may acceptably remain on the surface.

Many simple materials otherwise suitable as sealing materials in this invention may be found not to have the requisite cohesive strength. They may still however be used, if they are reinforced, for example by incorporating them in a porous support, such as an open cell foam, which can reduce the bulk elongation of the material.

In general, we prefer that the sealing material comprises a soft, high-temperature-slump-resistant, springy gel composition, by which is meant a liquid-extended polymer composition having a cone penetration value (measured by a modified version of ASTM D217, as described in European Patent Application No. 0371641) within the range from 100 to 400, (preferably 100 to 350), (10^{-1} millimetres); an ultimate elongation (measured by ASTM D412 as described below) greater than 100%, with substantially elastic deformation (i.e. substantially no hysteresis) to an elongation of at least 100%; ultimate tensile strength (ASTM D412) less than 1 Mega Pascal; dynamic storage modulus (as hereinafter described) less than 50,000 Pascals; and substantially zero slump at temperatures up to 120°C, preferably 150°C, especially 180°C. The composition may either contain a three-dimensional network of cross-linked molecular chains (gels) or may merely behave as if it contained such a network (gelloids), both being included in the term "gels" as used hereinafter.

Particularly useful are such gel compositions comprising at least 4% by weight of the gelling polymer and a least 5000 parts by weight of extender liquid per 100 parts by weight of the polymer, in which the gelling polymer mainly (more than 50%, preferably more than 75%, more preferably more than 90%, and especially more than 95%, by weight, or substantially entirely, comprises a styrene-alkylene-styrene block copolymer having

relatively hard polystyrene blocks and relatively elastomeric (preferably hydrogenated rubber) blocks. Examples of such copolymers include styrene-butadiene-styrene (SBS) and styrene-ethylene-butadiene-styrene (SEBS) triblock copolymers.

Particularly suitable gels are described and claimed in European Patent Application No. 0371641, the entire disclosure of which is incorporated herein by reference.

The sealing material will of course preferably be electrically insulating (although there are applications where it need not be) and it preferably has a volume resistivity of at least 10^9 ohms cm. Additionally, it will preferably be hydrolytically stable, moisture insensitive, and substantially inert towards the surface.

The force required to maintain the sealing material under compression can be chosen to be high enough to counter any intrusion of water or other contaminants, but low enough to allow for easy installation and no or limited displacement of the sealing material from the cover means. This force can easily be varied for example, by merely tightening or loosening the screws holding the cover fixed to the surface of the connector module, or adjusting the height of the compression means.

The invention will now be specifically described with reference to and as illustrated in the accompanying Drawings in which:

Figure 1A shows a plan view of a typical telecommunications connector module;

Figure 1B shows the same connector module in side elevation; and

Figure 1c shows a section along the line A-A of Figure 1b;

Figure 2 shows in plan view an article according to the invention;

Figure 3 shows the same article in side elevation; and

Figure 4 shows the article in end elevation.

Referring to the Drawings, Figures 1(a), (b) and (c) show a typical connector module of the type DP or XCC as used by the Turkish PTT. The module 1 has threaded screw holes 2 on its front face and screws 3 which can be tightened to make the appropriate electrical connections with telephone wire pairs (not shown).

The article of the invention is depicted in Figures 2-4.

A cover plate 4, 1.6 mms in thickness, is moulded in black plastics material to approximately the same dimensions as the connector module. The cover plate has connecting holes 5 and a reinforcing rib 6 (as shown in Figure 2).

The upstanding projections 7 project above the surface so as to form a lateral channel within which a compression bar can be seated.

As can be seen from Figures 3 and 4, the cover plate is filled with gel 8, and the mass of gel extends a little below the side walls 9. The gel may be a homogenous mass of material, or it may be provided in two or more adherent layers (not shown) which can be peeled off. In this way, by peeling off all or part of a bottom layer, the thickness of the gel material can be varied to suit a particular application. The concept of providing a multiply-layered gel which can be adjusted in height or depth to suit a particular application is an independent feature of the invention.

In a first method the article may be applied by removing four screws on the connector module corresponding to the

connecting holes 5 on the cover plate, applying the article to the face of the connector module and re-inserting the screws through the connecting holes 5 into the threaded screw holes 2. For easier re-entry, the four screws 3 may be replaced with headless threaded bolts, and wing nuts used to fix the cover plate to the connector module. Adjustment of the screws 3, or the wing nuts if used, enables pressure on the gel to be varied. It can readily be judged by eye when the gel has been sufficiently compressed to seal the connections on the face of the connector module.

In a second method, a compression bar can be laid across the cover 4 between the projections 7, and resting on the reinforcing rib 6. The bar can be mounted at any suitable point on the cabinet and is preferably provided with adjustable mounting means so that the compression force on the connector modules can be varied. The viscosity of the gel is such that it does not extrude to any substantial extent though the fixing holes in the cover, which in this method are of course not used.

CLAIMS

1. A method of environmentally sealing an electrical apparatus having a surface provided with a plurality of wire interconnection means, by means of an article comprising:
 - (a) a sealing material; and
 - (b) cover means for containing the sealing material; which method comprises:
 - (1) applying the article to the surface such that the sealing material is compressed against the surface; and
 - (2) fixing the cover means against substantial movement with respect to the surface by either (i) connecting it to one or more of the wire interconnection means in such a manner that the sealing material is maintained under compression between the cover means and the substrate, or (ii) applying a compression means against the cover means, the compression means cooperating with upstanding projections on the cover means, so as to maintain the sealing material under compression between the cover means and the substrate.
2. A method of environmentally sealing an electrical apparatus having a surface provided with a plurality of screw-threaded holes, by means of an article comprising:
 - (a) a sealing material; and
 - (b) cover means for containing the sealing material; which method comprises:
 - (1) applying the article to the surface such that the sealing material is compressed against the surface; and
 - (2) fixing the cover means against substantial movement with respect to the surface by connecting it to one or

more of the screw-threaded holes in such a manner that the sealing material is maintained under compression between the cover means and the substrate.

3. A method according to Claim 1, in which the cover means is provided with one or more fixing holes, or with one or more upstanding projections and the cover means is fixed against substantial movement with respect to the surface either by screws passing through the holes or by cooperation between the projection(s) and a compression means resting against the cover means.
4. An article for environmentally sealing an electrical apparatus comprising:

a sealing material; and
cover means for containing the sealing material;
wherein the sealing material is provided in two or more adherent layers at least one of which can be peeled off to vary the thickness of the sealing material.

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Fig.1 (a).

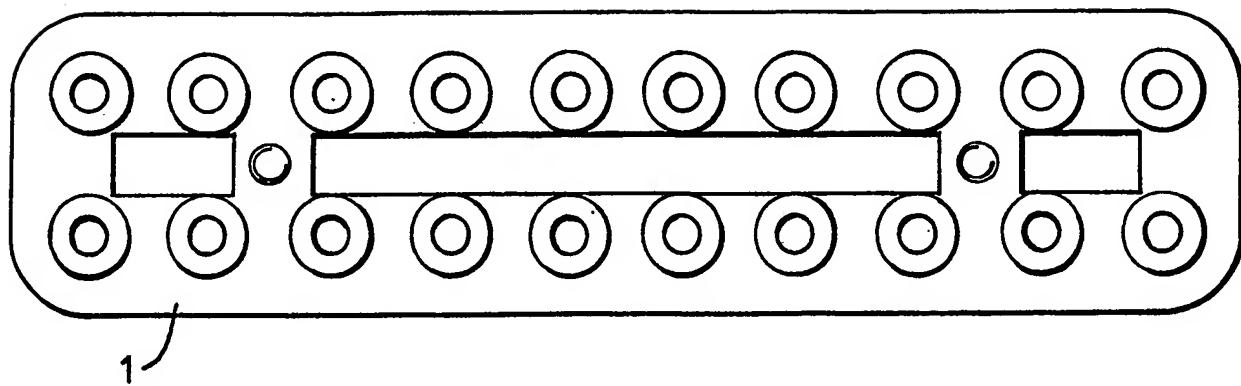


Fig. 1(b).

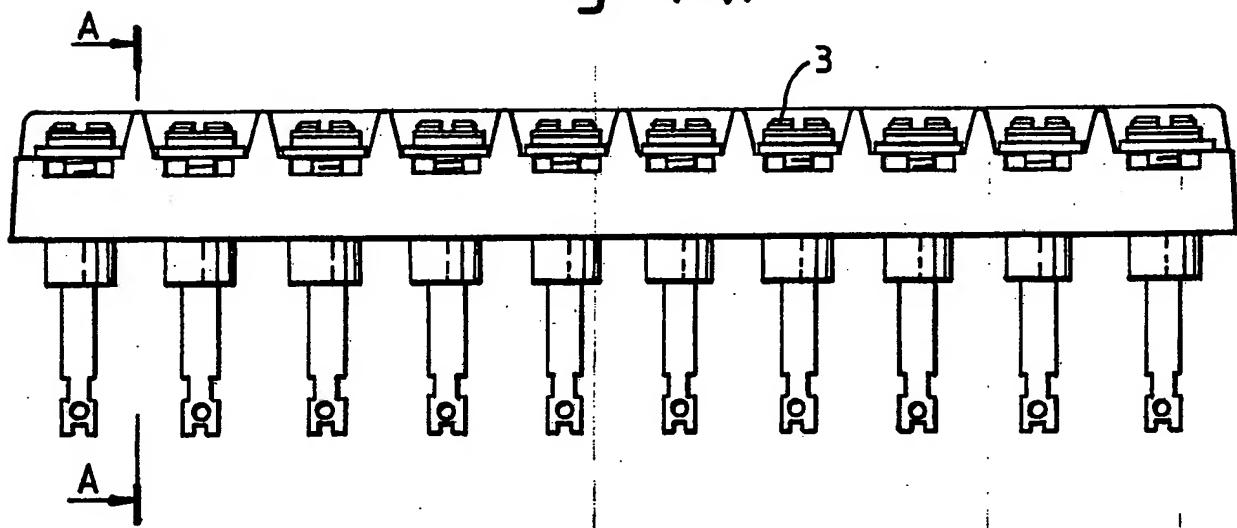
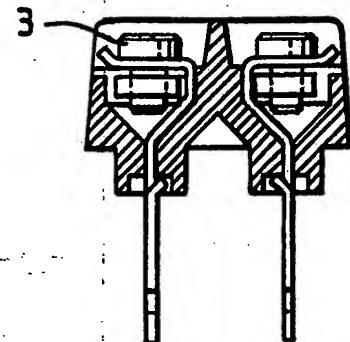


Fig. 1(c).



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Fig.2.

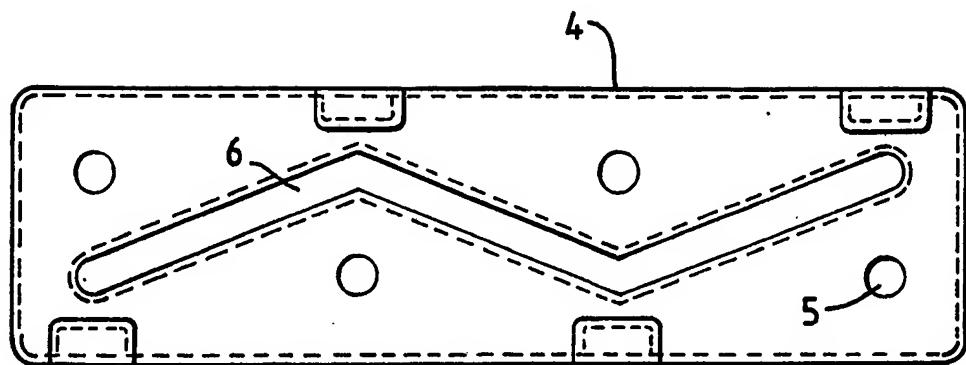


Fig.3.

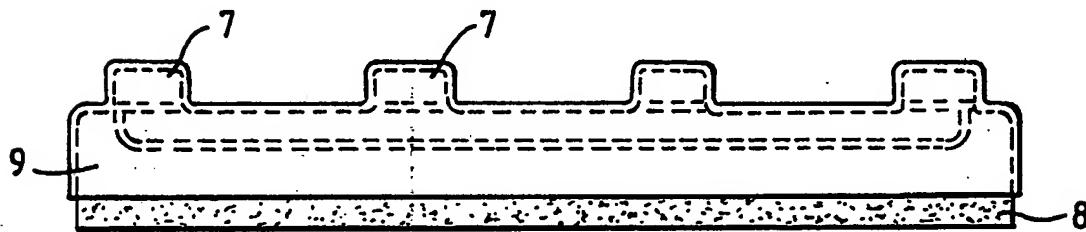
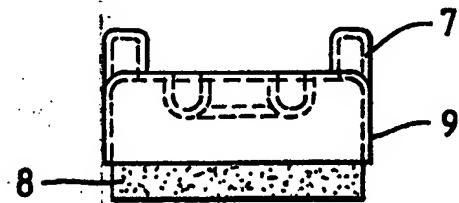


Fig. 4.



INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 91/01904

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all)⁶

According to International Patent Classification (IPC) or to both National Classification and IPC
IPC5: H 01 R 4/70

II. FIELDS SEARCHED

Minimum Documentation Searched⁷

Classification System	Classification Symbols
IPC5	H 01 R, H 02 G, H 05 K

Documentation Searched other than Minimum Documentation
to the Extent that such Documents are Included in Fields Searched⁸

III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹

Category *	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
X	EP, A3, 0108518 (RAYCHEM CORPORATION) 16 May 1984, see page 12, line 27 - page 14, line 15	1-3
A	---	4
X	US, A, 4718678 (N.V. RAYCHEM S.A.) 12 January 1988, see column 1, line 41 - column 2, line 12; column 6, line 62 - column 7, line 3	1-3
A	---	4
X	US, A, 4909756 (RAYCHEM CORP.) 20 March 1990, see the whole document	1-3
A	---	4

* Special categories of cited documents:¹⁰

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IV. CERTIFICATION

Date of the Actual Completion of the International Search

24th February 1991

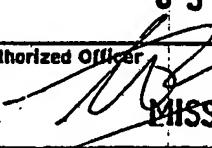
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III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	US, A, 4741709 (RAYCHEM CORPORATION) 3 May 1988, see column 3, line 16 - line 34; abstract -----	1-4

**ANNEX TO THE INTERNATIONAL SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
EP-A3- 0108518	16/05/84	AU-B-	573728	23/06/88
		AU-B-	598336	21/06/90
		AU-D-	1063588	28/04/88
		AU-D-	2004483	19/04/84
		CA-A-	1249351	24/01/89
		CA-C-	1264610	23/01/90
		GB-A-B-	2133026	18/07/84
		GB-A-B-	2168363	18/06/86
		JP-A-	59090988	25/05/84
		US-A-	4600261	15/07/86
		US-A-	4634207	06/01/87
		US-A-	4864725	12/09/89
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		CA-A-	1257671	18/07/89
		EP-A-B-	0189240	30/07/86
		US-A-	4610738	09/09/86
		WO-A-	86/04181	17/07/86
US-A- 4741709	03/05/88	NONE		

For more details about this annex : see Official Journal of the European patent Office, No. 12/82